Claims

What is claimed is:

1. Apparatus, comprising:

a die

a heat spreader; and

a thermal intermediate material comprised of a plurality of carbon nanotubes blended with solder, the thermal intermediate material interposed in a gap between the die and the heat spreader.

2. The apparatus of claim 1, wherein some of the carbon nanotubes of the plurality of carbon nanotubes are chemically bonded to the solder.

3. The apparatus of claim 2, wherein the some of carbon nanotubes of the plurality of carbon nanotubes are pre-coated with a metal prior to blending with the solder.

4. The apparatus of claim 2, wherein some of the carbon nanotubes are decorated with metal.

5. The apparatus of claim 3, wherein the metal is platinum.

6. The apparatus of claim 3 wherein some of the carbon nanotubes are pre-coated with a metal to wet the solder to bond it to the carbon nanotubes.

7. The apparatus of claim 3, wherein the metal is selected from the group consisting of gold, platinum, silver and palladium and alloys comprising one or more of gold, platinum, silver and palladium.

8. The apparatus of claim 1, wherein some of the carbon nanotubes are aligned in the thermal intermediate material along the heat flow path between the die and the heat spreader.

9. The apparatus of claim 1 wherein the nanotubes are randomly oriented in the thermal intermediate material and have average lengths less than about 10 percent of the gap between the die and the heat spreader.

10. The apparatus of claim 1 wherein the solder is indium.

11. A composition, comprising:

a matrix, wherein the matrix exhibits a phase change between about 100° C and about 230° C.

a distribution of carbon nanotubes in the matrix having a length range from about 0.5 micron to about 10 micron, and wherein the interstitial carbon nanotube heat transfer structures occupy from less than about 5 to about 30 volume percent of the composition.

12. The composition of claim 11, wherein the matrix is a metal selected from the group consisting of indium or an indium alloy.

13. The composition of claim 12, wherein the carbon nanotubes are decorated with metal.

14. The composition of claim 13 wherein the metal is selected from the group consisting of platinum, gold, silver and palladium and their alloys.

15. A method, comprising:

forming a billet of solder incorporating a plurality of carbon nanotubes thereon which are chemically bonded to the solder;

aligning a substantial percentage of the carbon nanotubes with an axis of the billet; and

slicing the billet perpendicular to the axis into thermal intermediate blanks having a thickness substantially less than their length or width.

16. The method of claim 15, wherein aligning the nanotubes comprises:

working the billet by a process selected from the group consisting of rolling, extruding or pultruding.

17. The method of claim 15 wherein the thermal intermediate blank is interposed in a gap between a die and a heat sink.

18. The method of claim 15, wherein the gap between the die and the heat sink is from less than or equal to about 5 microns to about 250 microns.

19. A method comprising

forming thermal intermediate structure comprised of a plurality of metal decorated carbon nanotubes blended with solder with at least some of the plurality of carbon nanotubes substantially aligned with a thermal axis of the billet;

coupling a first surface of the thermal intermediate structure to a surface of a heat sink with the thermal axis of the thermal intermediate material oriented substantially perpendicular to the surface of the heat sink; and

coupling a second surface of the thermal intermediate structure to a surface of a heat source.

20. The method of claim 19, wherein coupling a surface of the heat source to the second surface of the thermal intermediate structure comprises forming a solder bond between the surface of the heat source and the second surface of the thermal intermediate structure.

21. The method of claim 19, wherein coupling a surface of the heat sink to the billet comprises forming a solder bond between the surface of the heat sink and the first surface of the thermal intermediate structure.

22. The method of claim 21, wherein forming a solder bond also comprises applying a solder wetting coating to the surface of the heat source and melting the second surface of the thermal intermediate structure to form a bond with the solder wetting coating.

23. The method of claim 21, wherein forming a solder bond comprises applying a solder wetting coating to the surface of the heat sink and melting the first surface of the billet to form a bond with the solder wetting coating.

24. A computing system, comprising:

at least one dynamic random access memory device;

a die including a die surface and a circuit to electrically couple to the memory device;

a heat sink; and

a thermal intermediate structure interposed between the die surface and the heat sink and comprising a plurality of carbon nanotubes, some of which are decorated with metal and blended with solder.

25. The system of claim 24, wherein the circuit comprises a processor that acts upon data signals, and may include, for example, a microprocessor.

26. The system of claim 24, wherein the metal is one or more metals selected from the group consisting of platinum, gold and silver and alloys of one or more of platinum gold and silver.

27. The system of claim 24 wherein the solder is indium.